Unit

16

CURRENT ELECTRICITY

Q. Define electricity.

Ans. Definition:-

The branch of physics in which we study about the charges in motion is called 'electricity'.

Q. Define electric current and write its unit.

Ans. Electric Current:

Definition:-

The rate of flow of electric charge through any cross-sectional area is called electric current.

Mathematical Form:-

If Q charge is passing through an area in time t. Mathematically it can be written as

$$I = \frac{Q}{t}$$

Unit:-

In SI unit, it is measured in ampere.

Definition of ampere:-

One ampere current flows through a conductor, if one coulomb of charge passes through any cross-sectional area of conductor in one second then the current flowing through that conductor would be, one ampere.

Note:- In electrolytes current flows due to positive charge and negative charge.

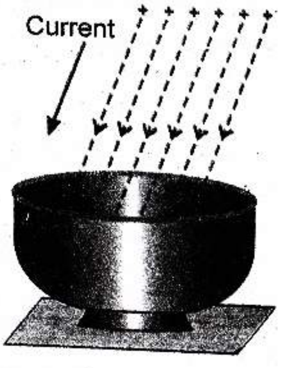
CONVENTIONAL CURRENT:

Definition:-

"The current due to positive charge carries equivalent to negative charge flowing in the opposite direction is called Conventional Current."

Explanation:-

Consider a stream of positively charged particles is injected in a metal cup due to this, we will say that electric current is flowing at the upper cross section of the metallic cup, due to this current positive charge is increasing in the cup. So electric current is flowing into the cup. And direction of current is same as direction of motion of positively charged particles.



If now, the stream of negative charge is introduced into the cup, then these negative charge will neutalize the positive charges in the cup. We suppose here that positive charged particles are flowing out of the cup. Thus the effect of flow of current due to negative charge is the same as that of the current due to an equal amount of positive charge flowing in the opposite direction. So direction of current is reversed, and this direction is

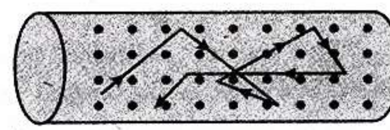
opposite to that of negative charge. Hence we can say that "Electric Current" is along the direction of flow of positive charge and is in opposite direction of flow of negative charge.

Assumption:-

Whenever current flows due to the motion of negative charge, it is substituted by its equivalent positive charge.

Q. Why current does not flow in Conductors in normal state?

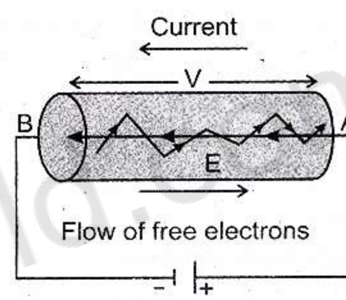
Ans. Consider the flow of electric current in copper wire (conductor). It has large number of free electrons, which are in random motion. In the absence of electric field, the rate at which the free electrons cross any section of the wire from right to left is equal to the rate from left to right in wire and hence the net result is zero due to this reason we do not feel any current when we touch it in the absence of electric field.



Q. Why does current flow in the presence of electric field through conductor?

Ans. Now if one end of copper wire is connected with the positive terminal and the other with negative terminal of battery, an electric field 'E' is established at each point of wire.

Now the free electrons, because of their negative charge, experience a force in a direction opposite to the direction of electric field E.

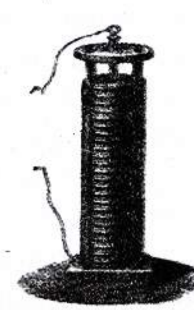


Because of this force, a net directed flow of free electrons takes place from the negative terminal of the battery towards its positive terminal and an electric current begins to flow from the positive terminal towards the negative terminal of the battery. Note the current flow due to negative charges has been changed with conventional current. This current flows in the wire from positive to negative terminal of the battery that is current flows from a point of higher potential to a point of lower potential.

Q. What is difference between Potential Difference and (e.m.f) Electromotive force?

Ans. **Potential Difference and emf:**

Definition: Potential Difference "The potential difference between two points can be defined as the energy supplied by a unit charge as it moves from one point to the other".



The first battery was made in 1800, which consists of copper and zinc plates soaked in salt water.

Explanation: When one end A of a conductor is connected to the positive terminal and its other end B is connected to the negative terminal of the battery, then the potential of A becomes higher than the potential of B. An electric field is set up due to which the current flows from A to B. This flow of current is due to the motion of free electrons from B to A. For continuous flow of current, it is essential that when the electrons after passing through the conductor reach the positive terminal A of the battery, they should be pumped from here to the negative terminal B through the battery. This transfer of electrons in the battery takes place due to a chemical process which provides the necessary energy for pumping the electrons.

Electromotive force e.m.f

"The amount of energy supplied by the battery in pushing one coulombs charge (electrons) from its positive terminal to its negative terminal through the battery is known as the electromotive force e.m.f."

When a conductor is connected across the terminals of the battery, electrons begin to flow through it. During their flow, they face a resistance due to the collisions with the atoms present in the conductor.

Potential Difference

"The energy supplied to electrons by the battery, is utilized in over coming this resistance and is dissipated as heat and other forms of energy. The dissipation of this energy is accounted for by the potential difference across the two ends of the conductor". Thus the emf in a circuit gives the energy supplied to unit charge by the battery and the potential difference accounts for the dissipation of this energy into other forms as unit charge passes through the circuit.

Q. State Ohm's Law and explain it. **(L. B '09)**

Ans. **<u>OHM'S LAW</u>**

Statement:-

The amount of current "I" passing through a conductor is directly proportional to the potential difference applied across its ends, provided the temperature and the physical state of the conductor does not change.

Mathematical Form:

$$V \propto I$$

$$\boxed{V = IR}$$

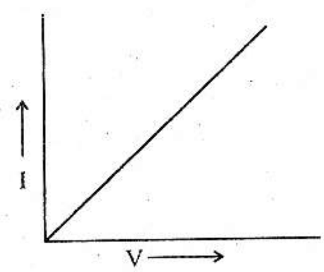
Where 'R' is constant of proportionality and is called resistance of conductor. The value of 'R' depends upon the conductor and is different for different conductors.

Unit of Resistance:

The unit of 'R' is ohm (Ω)

Definition of ohm:

A conductor would have resistance of one ohm ($1\ \Omega$), if there is a current of one ampere flowing through it, when the potential difference across it is one volt.



Graph:-

If a graph is drawn between V and I, it will be a straight line showing that V and I are directly proportional to each other, for metallic conductors.

Limitations of ohm's Law:

1. It is applicable for those conductors in which temperature and physical state does not change.
2. It is applicable only in metallic conductors.

Q. Define Resistance and write its effect on current.

Ans. RESISTANCE:

Definition:

The property of a substance which opposes the flow of current through it, is called its resistance.

Mathematical Form:

$$\text{Resistance} = \frac{\text{Potential Difference}}{\text{current}}$$

$$\boxed{R = \frac{V}{I}}$$

Effect:

If the value of 'R' is large then the value of current would be small and if R is smaller the current would be larger. Its value can be determined by V-I graph.

Q. What are the factors upon which the resistance of conductor depends? What is meant by specific resistance?

Ans. Resistance of conductor depends upon following factors.

i) Length of Conductor
ii) Cross Sectional Area
iii) Nature of Conductor

i) Length of Conductor:

Resistance 'R' is directly proportional to length of conductor. It means if length is doubled resistance also doubles and if length is halved, then the resistance would become one half.

$R \propto L$ --------------------- (1)

ii) Cross – sectional area (A):

Resistance is inversely proportional to cross-sectional area.

$R \propto \frac{1}{A}$ --------------------- (2)

It means, a thick wire would have low resistance than a thin wire.

Combining (1) & (2).

$$R \propto \frac{L}{A}$$

$$R = \rho\frac{L}{A}$$

Where ρ is specific resistance of material. It is a mathematical formula to calculate resistance of conductor. The value of 'ρ' depends upon nature of conductor.

(iii) Nature of Conductor:

The resistance of conductor depends upon nature of conductor also.

Specific Resistance (ρ)

Definition:-

Resistance of 1 meter cube of a substance is called specific resistance.

Mathematical Form:-

$$R = \rho \frac{L}{A}$$

$$\rho = R \frac{A}{L}$$

If $L = 1m$, $A = 1m^2$,

$$R = \rho$$

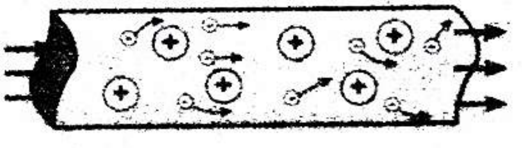
Unit of (ρ):

Its unit is ohm-metre (Ωm)

Q. Write the effect of temperature upon resistance.

Ans. Effect of temperature upon resistance:

Usually a metallic conductor has a crystalline structure in which its various atoms in form of positive ions are fixed at their respective places as shown in fig. Free electrons move in the space between these atoms. During the course of their motion, they continuously collide with the atoms. After collision they scatter in various directions. **When we apply a potential across the ends of the conductor, the free electrons, in addition to their random motion, have a directed motion with a velocity known as drift velocity.** The current flows through the conductor due to this velocity. The opposition to flow of current is caused by the collision of free electrons with the atoms of the conductor because after each collision the direction of motion of the electrons randomly changes which slows down the drift velocity. More frequently electrons collide with the atoms, the larger is opposition or resistance in the flow of current. When the temperature of the conductor rises, average speed of the random motion of the free electrons increases which enhances the rate of collision of electrons and the atoms. This causes an increase in the resistance of the conductor. **The increase in resistance is directly proportional to the increase of temperature.** If R_o is the resistance at 0^oC and R_T at T^oC, then we can write as:



$R_T - R_o \propto R_o$ -- (I)

$R_T - R_o \propto T$ -- (II)

Combining I and II

$R_T - R_o \propto R_o \times T$

$R_T - R_o = \alpha R_o \times T$

Here α is a constant which is **the rate of increase in resistance per ohm per Kelvin rise in temperature.**

Resistance Thermometers:

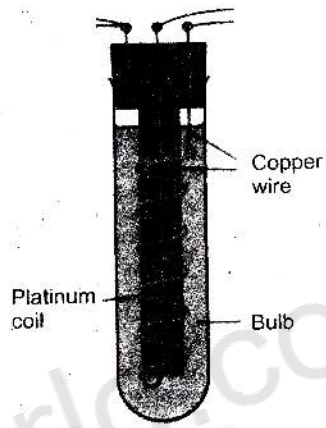
Definition: "It is that instruments which measures the temperature and resistance of different conductors".

By taking measurements of the resistance of a conductor of known value of α, at different temperatures, it is possible to measure the temperature. This is the principle on which a resistance thermometer works.

Resistance thermometer:

Principle:

The conductor used in resistance thermometer is usually a platinum wire, the ends of which are welded with thick copper wire. Before measuring the temperature of a substance, the thermometer is placed in melting ice and its resistance at 0°C is measured. Let it be R_o ohm. Then the bulb of the thermometer is placed into the substance whose temperature is to be measured. The resistance of the platinum wire is again measured. Let this time its value be R_T ohm. According to Eq.



$$T = \frac{R_T - R_o}{R_o \times \alpha}$$

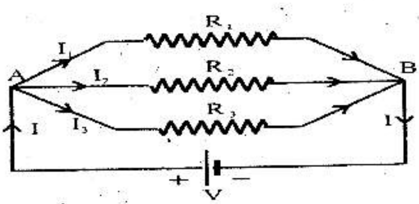
In this equation α is the rate of increase in the resistance of platinum per ohm per Kelvin rise of temperature. Its value is $3.9 \times 10^{-3}\ K^{-1}$. Temperatures from -260°C to 630°C can be measured by a platinum resistance thermometer.

Q. How are resistances connected in parallel? Write the characteristic features of this combination. What is meant by equivalent resistance of parallel combination?

Ans. Parallel Combination:

Definition:-

When a number of resistances are connected together in such a way that all the connections of one end of resistors are collected at one common point and all the connection of other end are collected together at another common point, and voltage is applied between these two common (as A and B points in fig.) points, then such a combination is called parallel combination of resistances.



Characteristics:-

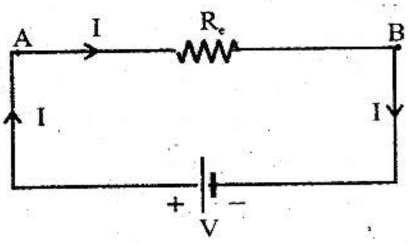
The potential difference across each resistance is same, in this parallel combination. The current flowing in different resistances is not same.

The total current drawn from the source is equal to sum of current flowing in all individual resistances connected in parallel. It can be represented in the form of equation as:

$I = I_1 + I_2 + I_3$

Where I_1, I_2 and I_3 are current flowing in R_1,R_2 and R_3 respectively. Their values by ohm's law are as under.

$I_1 = \frac{V}{R_1}$, $I_2 = \frac{V}{R_2}$ $I_3 = \frac{V}{R_3}$



After putting the values

$$I = \frac{V}{R_1} + \frac{V}{R_2} + \frac{V}{R_3}$$

$$I = V\left(\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}\right)$$

$$\frac{I}{V} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$$

The single resistance, which can replace the parallel combination of a number of resistances is called equivalent resistance, (R_e). The single resistance can draw the same value of current from the same voltage source. Now for equivalent resistances, by ohm's law.

$V = IR_e$, $\frac{V}{I} = R_e$

$$\frac{I}{V} = \frac{1}{R_e}$$

$$\frac{1}{R_e} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$$

For 'n' number of resistances, in parallel combination equivalent resistance is:

$$\frac{1}{R_e} = \frac{1}{R_1} + \frac{1}{R_2} + \text{-----------} \frac{1}{R_n}.$$

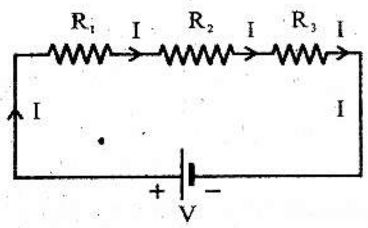
NOTE: **The equivalent Resistance of parallel combination is smaller than the smallest resistance of the combination.**

Q. How resistances are connected in series? Describe the characteristics of this combination. What is meant by equivalent resistance of series combination? Find its value.

Ans. **<u>Series Combination:</u>**

Definition:-

When a number of resistances (R_1,R_2,R_3) are connected together so that the current (I) flowing in each resistance is same, and these are connected one after the other, such combination of resistances is called series combination.



Characteristics:

1- The resistances are connected end to end and circuit provides only one path to flow for current.

2- The magnitude of current that passes through each individual resistance is same.

3- The sum of voltages across each of the resistance is equal to the voltage of the battery connected across the combination. Mathematically.

$V = V_1 + V_2 + V_3$

Where V_1,V_2 and V_3 are the voltages across R_1, R_2, & R_3 and V is voltage of battery.

Now by using ohm's law.

$V_1 = IR_1$

$V_2 = IR_2$

$V_3 = IR_3$

$V = IR_1 + IR_2 + IR_3$

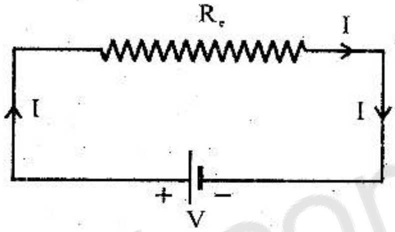
$V = I(R_1+R_2+R_3)$

$R_e = \frac{V}{I} = R_1 + R_2 + R_3$ ------------ (A)

$R_e = R_1 + R_2 + R_3$

4. Equivalent resistance:

"The equivalent resistance of any combination is that resistance which when substituted in place of combination does not alter the value of current".



When this resistance is connected across the same battery the same value of current flows in the circuit. Now by using Ohm's law.

$V = IR_e = I(R_1+R_2+R_3)$

$\Rightarrow \boxed{R_e = R_1 + R_2 + R_3}$

It is required formula to calculate the equivalent resistance of series combination.

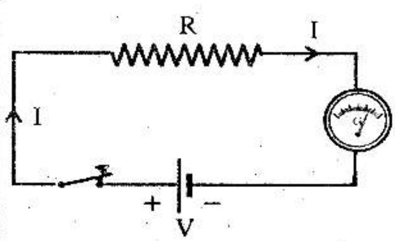
5- For n-number of resistances.

$R_e = R_1 + R_2 + R_3 + \text{------------} + R_n$

Note: The equivalent resistance of series combination is greater than the greatest resistance in the combination.

Q. What is Galvanometer? Explain briefly. How can we use it for the measurement of current and potential difference?

Ans. Galvanometer is a very sensitive electrical instrument by which, we can detect the presence of electric current in circuit.



<u>Construction and Working:</u>

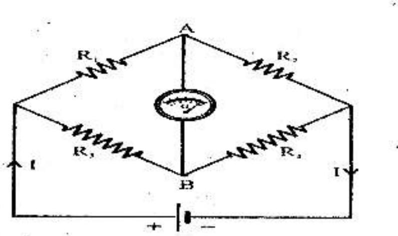
Apparently it consists of a dial on which a needle can rotate.

<u>Detection of current</u>

In order to detect current in a circuit, the galvanometer is connected in the circuit in series.

<u>Detection of potential difference</u>

Galvanometer is also used to indicate potential difference between two points of a circuit. Fig. shows an electrical circuit. If we have to find whether its points A and B are at the same potential or not, a galvanometer is connected between these points. If the galvanometer shows a deflection, it would indicate that a current is passing through the



galvanometer. This would happen only in the case when there is a potential difference between the points A and B. If the galvanometer shows no deflection the points A and B would be at the same potential.

Q. Write a note on Ammeter? How can we convert galvanometer into ammeter?

Ans. Definition:

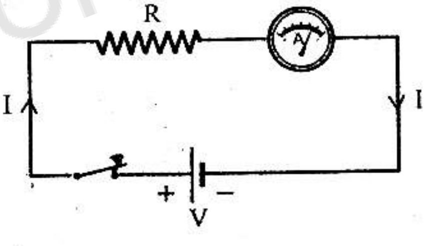
The electrical instrument which is used to measure the current in a circuit is called Ammeter.

Explanation:

Galvanometer is a very sensitive instrument. Only a current of few milli-ampere is sufficient to cause full-scale deflection in it. Therefore it cannot be used directly to measure current because usually during experiments, current in a circuit is quite large.

Conversion of galvanometer into ammeter

A galvanometer is used to measure large values of current. Conversion of galvanometer into ammeter this modification is accomplished by connecting a suitable low resistance in parallel with the galvanometer. This resistance is known as shunt. Shunt provides an alternate path for the current to flow. The major part of the total current passes through the shunt and a small fraction of it flows through the galvanometer. In this way the range of the galvanometer for current measurement is considerably increased. This modified galvanometer is known as **ammeter**. Usually the resistance of the shunt is very small. As in ammeter it is connected in parallel with the galvanometer, hence the resistance of an ammeter is very low.

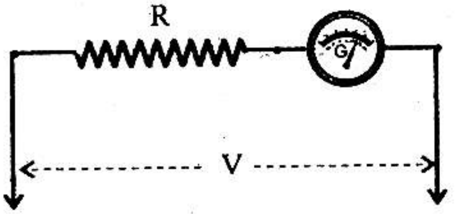


Measurement of current

In order to measure current in a circuit, the ammeter is connected in series, so the current flowing in the circuit also passes through the ammeter. As the resistance of the ammeter is very small, so its introduction into the circuit does not affect the current of the circuit.

Precautions

Before connecting an ammeter in the circuit, one should see that the current to be measured lies within the range of the ammeter. Usually the needle of the ammeter moves only in one direction. If it is made to move in opposite direction it is likely to be damaged.



Therefore when an ammeter is connected in a circuit, this precaution should be observed that the current enters the ammeter through its terminal marked positive (+).

Q. Write a note on Voltmeter. How can we convert galvanometer into voltmeter?

Ans. VOLTMETER:

Definition:

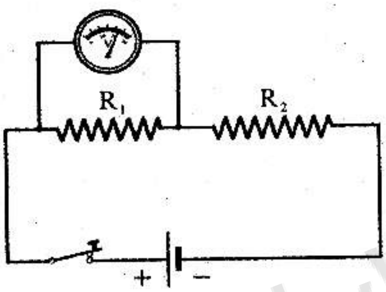
The device used to measure the potential difference is called voltmeter.

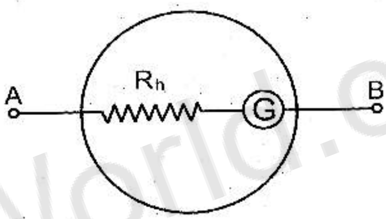
Explanation:

When current passes through a resistance R, there would be a potential across its two ends the value of which is equal to V = IR. This potential difference can be directly measured by an instrument known as voltmeter.

Conversion of galvanometer into voltmeter

Conversion of galvanometer into ammeter galvanometer is converted into a voltmeter by connecting a suitable resistance in series with it as shown in fig. The value of this series resistance depends upon the range of the voltmeter. Usually its value is several thousand ohms. Thus the resistance of a voltmeter is very high.





Connection of voltmeter in circuit

Voltmeter is always connected in parallel with the resistance across which the potential difference is to be measured. Higher the resistance of the voltmeter, more reliable would be its readings. If the resistance of the voltmeter is comparatively low, it will draw more current from the circuit. Due to this the potential difference across the resistance for the measurement of which the voltmeter was connected, would drop. Therefore a good voltmeter should have such a high resistance so that no or very little current passes through it.

Precautions

When a voltmeter is connected in a circuit, care should be taken to connect its terminal marked positive (+) to that end of the resistance which is at a higher potential.

Q. Define Joule's law and explain it.

Ans. Definition:

"The amount of heat energy generated in a resistance due to flow of electric current is equal to the product of the square of current I, the resistance R and the time duration 't'. This is known as Joule's Law." Mathematically it can be written as

$$\boxed{W = I^2Rt}$$

Energy

Consider two points having a potential difference of V volts. If one coulomb of charge passes between these points, the amount of energy supplied by the charge would be V Joule. Hence when Q coulomb of charge flows between these two points, then we will get QV joule energy.

If we represent this energy by W, then

$$W = QV$$

Charge

As current is the rate of flow of charge, so if a current I ampere flows for time t between two points, then during this time interval I x t coulomb of charge will flow. So the energy supplied during t second is

$$W = QV = I \times t \times V \text{ ------------------------}(1)$$

Potential

If a current is passing through a resistance R and the potential difference across its ends is V, then by Ohm's law.

$$V = I \times R$$

Substituting the value of V in Eq. (1)

$$W = I^2 Rt$$

Uses

This energy can be utilized for different functions. **For example** fans convert this energy into mechanical energy, bulbs into light and heaters into heat. Usually this energy appears as heat in the resistance. This is the reason that we get heat when current passes through a heater.

Q. Define electric power and its unit.

Ans. Electric Power:

The amount of energy supplied by current in unit time is known as electric power. Hence power P can be determined by dividing the electric energy W by the time t i.e.

$$\boxed{P = \frac{W}{t}}$$

$$P = \frac{QV}{t}$$

$$P = \frac{I \times V \times t}{t} \quad \therefore \quad Q = I \times t$$

$$P = IV$$

$$\boxed{P = I^2R} \quad \therefore \quad V = IR$$

$$\boxed{P = \frac{V^2}{R}} \quad \therefore \quad I = \frac{V}{R}$$

$$\boxed{\therefore \quad V = IR}$$

When current I is flowing through a resistance R, the electric power that generates heat in the resistance is given by $I^2 R$.

Unit:

The unit of electric power is watt, which is equal to one joule per second. It is represented by word "W". Electric bulbs commonly used in houses consume 25W, 40W, 60W, 75W and 100W of electric power.

Q. Define kilowatt hour Also prove that 1 kWh = 3.6 MJ

Ans. Kilowatt Hour:

Electric energy is commonly consumed in very large quantity for the measurement of which joule is a very small unit. Hence a larger unit of energy is required which is called kilowatt-hour.

Definition:

It is the amount of energy obtained by a power of one kilowatt in one hour.

$$1\text{kWh} = 1000 \text{ W} \times 1 \text{ hour}$$
$$= 1000 \frac{j}{s} \times (3600s)$$
$$= 1000 \times 3600 \text{ j}$$
$$= 10^3 \times 36 \times 10^2$$
$$= 36 \times 10^5 \text{j}$$
$$= 3.6 \times 10^6 \text{j} = \boxed{3.6MJ}$$

Q. How energy is obtained in Kilowatt hour?

Ans. The energy in kilowatt-hour can be obtained by the following formula.

$$\text{The amount of energy in kilowatt-hour} = \frac{\text{watt} \times \text{time (hour)}}{1000}$$

The electric meter installed in our houses measured the consumption of electric energy in units of kilowatt-hour according to which we pay our electricity bills. If the cost of one kilowatt-hour i.e., one unit is known, we can calculate the amount of electricity bill by the following formula.

To find cost of electricity:

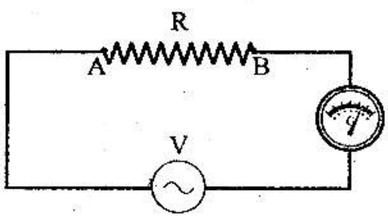
Cost of electricity = number of units consumed x cost of one unit

$$= \frac{\text{watt} \times \text{time of use in hours}}{1000} \times \text{cost of one unit}$$

Q. What is direct current and alternating current? **(L.B '10)**

Ans. Direct current and alternating current:

If positive and negative terminals of a battery are connected to the ends of a conductor, current begins to flow through it and the direction of its flow is from the positive end of the conductor towards its negative end.

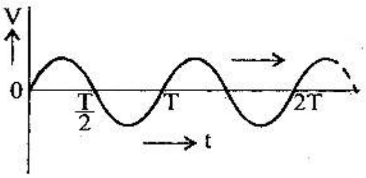


Direct Current:

Definition: "Such a current which always flows only in one direction is called direct current or d.c."

Alternating Current:

"A current, the direction of which changes again and again, this current is called alternating current or a.c. We will explain alternating current from fig.



Explanation:

Suppose a resistance R has been connected with a source of voltage which is such that the voltage of its end A changes with respect to the end B in accordance with the graph shown. Here you can see the shape of graph between the time intervals 0 – T, T – 2T and 2T – 3T is exactly the same. The shape of the graph remains same after the time interval T. **This time interval after which the voltage repeats its value is known as time period.** Now let us examine the type of current which passes through the resistance R due to such a voltage.

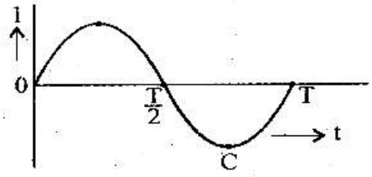
During the time interval 0 to T/2

The potential of the end A is positive with respect to end B, so the current in this interval flows from A to B. It starts from zero, gradually increases to its maximum value and then finally decreases to zero.

During the interval T/2 to T

The potential of end A gets negative with respect to B, so now the current flows in opposite direction from B to A. In this interval also, the current starts from zero, gradually increases to the maximum value in the opposite direction and finally decreases to zero. In this figure positive values of current indicate current flowing from A to B and the negative values from B to A.

After the period 0 – T, the next period starts. Again in this period from time T to 3T/2, the current flows from A to B and from 3T/2 to 2T from B to A. This continues in subsequent periods. Such values of current during one period is known as one cycle.



Frequency:

The number of cycles which the current completes in one second is known as its frequency. The frequency of a.c. used in our houses is 50 cycles per second.

Q. Write a note on electricity Hazards. Also define neutral wire and live wire?

Ans. Electricity hazards:

Electric energy is distributed to various houses in a city from a power station by means of two wires. One wire is earthed at the power station so it is at zero potential. It is called neutral wire. The other wire is at a certain potential. It is called live wire. There are following electricity hazards. Our body is a good conductor of electricity through which current can easily pass. Therefore if a person holds live wire, then because of the presence of voltage in it, current will start flowing to ground through the human body which may prove fatal for the person. In order to avoid such a situation, the wire carrying electricity in the houses should never be naked. Rather it should be covered with an insulator. Such an insulation covered wire is called cable. It is very

essential that the layer of insulation in the cable is perfect and is not damaged. A heavy current flows through the wire and it gets so hot that its insulation is burnt out and the wire becomes naked and it becomes dangerous.

Similarly constant friction also removes the insulation from the wire, whereas too much moisture also damages the insulation. In such a situation it is advisable to use a cable with two layers of insulation.

Q. Write the safe use of electricity in homes.

Ans. Safe uses of electricity in homes:

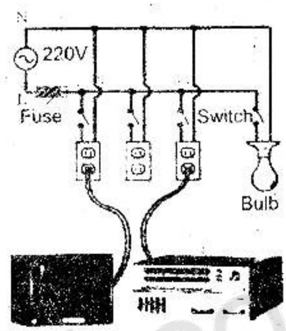
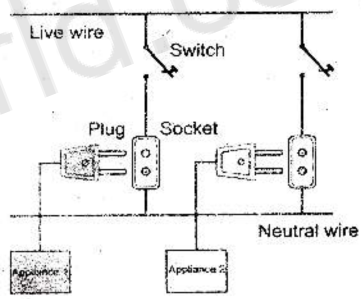


Figure shows a typical circuit used in houses for the supply of electricity.

(i) The various household appliances such as electric bulb, fan, electric iron and T.V. etc., are connected in parallel with the live and neutral wires through a switch.

(ii) Before connecting a switch in the circuit, it should be ascertained that the maximum current that would pass through the switch lies within its rated value.



(iii)It is very dangerous to connect an appliance directly with the live and neutral wire.

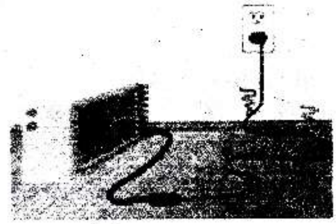
(iv)The connection is always made through a socket and a plug as shown in fig. When any appliance is desired to be connected to a circuit, then its plug is inserted into a socket. Thus terminals of the appliance are connected with live and neutral wires.

Q. Write Safe use of electricity through fuse.

Ans. Definition:

A small wire connected in series with the live wire is known as fuse wire or fuse.

Advantage of Fuse:



A specified value of current can safely pass through it. When the current passing it exceeds this limit, it gets so hot that it melts. The fuse wire is connected in series, in live wire. If we simultaneously switch on many appliances or due to fault in electrical wiring, live and neutral wires get short, a very heavy current passes which may damage the meter or burn the whole house. Here the fuse wire plays its role. As the fuse wire is in series with the live wire, so the short circuit current also passes through it. This current being much higher than the rated value of the fuse, blows the fuse off.

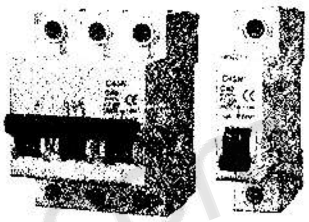
Thus the circuit gets open and the flow of current stops. After removing the fault of the circuit, the blown out fuse is replaced with a new one.

Determination of fuse wire rating:

We can determine the required fuse rating for a circuit. Suppose we want to insert a fuse for an air-conditioner or heater of power 3000W. If voltage supply is of 240V, then according to relation $P = V \times I$, We get $I = 12.5A$. The available fuses in the market are usually of rating 5A, 10A, 13A, 30A etc. Hence, suitable fuse for this circuit would be of 13A.

Q. Write Safe use of electricity through circuit breaker.

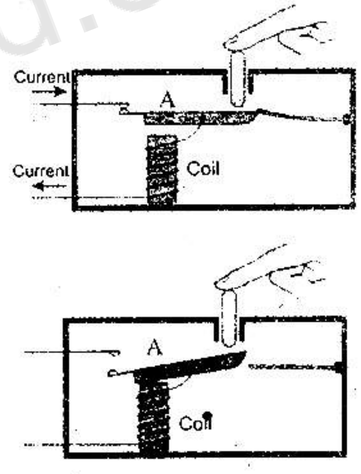
Ans. Definition:



It is a safety device which is used in place of fuse wire.

Due to any fault when the current exceeds the safety limit, then the button of the circuit breaker moves upward. Due to which the circuit breaks and the flow of the current stops in it. The button of the circuit breaker is pressed after the correction of the circuit. The circuit again gets completed and the current flows in it.

Principle of circuit breaker:



The principle of circuit breaker is explained in fig. The current flowing through the electric circuit, also flows through in the coil of the circuit breaker due to which the coil becomes electromagnet. When the current is within its limits, the contact points of the circuit are connected to each other and the circuit is completed. As soon as the current exceeds the limits, the magnetic force of the electromagnet is so increased that it attracts the iron strip 'A' towards it. Hence the contact points are separated and the circuit breaks.

Q. Write Safe use of electricity through earth wire.

Ans. Earth Wire:

Definition: "An additional wire which is used with live and neutral wire is called earth wire. It is used for safety from electric shock"

Explanation:

Most of our appliances such as electric iron, kettle, refrigerators and motors etc. are such that their outer part is of some metal. Usually the outer part is insulated from the live part of the appliance through which the current flows. Because of this insulation no current flows through the outer metal casing and one can safely touch it as we usually do.

Example 16.2:

The potential difference across an electric bulb is 220 V. If the current passing through it is 440 mA, then find the resistance of the bulb. If the potential difference is increased by 250 V, what would be the value of current?

Solution:

The given data is

Potential difference = V = 220V

Current = I = 440 mA = 440 x 10^{-3} A

Resistance = R = ?

Formula:

$$V = IR$$

$$R = \frac{V}{I}$$

Putting values we get

$$R = \frac{220}{440 \times 10^{-3}}$$

$$R = 0.5 \times 10^{3}\ \Omega$$

$\boxed{R = 500\ \Omega}$ **Ans**

$$V = IR$$

$$I = \frac{V}{R} = \frac{220}{500}$$

$$\Rightarrow I = 0.5\ A$$

$$I = 0.5 \times 1000\ mA$$

$\boxed{I = 500\ mA}$ **Ans**

Example 16.3:

Length of a copper wire is 1 metre and its diameter is 2mm. Find the resistance?

Solution:

The given data is

Length of conductor = L = 1m

Diameter of conductor = D = 2 x 10^{-3} m

Resistance = R = ?

To find area use the formula

$$A = \frac{\pi d^2}{4}$$

$$A = \frac{3.14 \times (2 \times 10^{-3})^2 m}{4}$$

$$A = 3.14 \times 10^{-6}\ m^2$$

$$\rho = 1.69 \times 10^{-8}\ \Omega m$$

We know that $R = \frac{\rho L}{A}$

Putting the value

$$R = 1.69 \times 10^{-8} \times \frac{1}{3.14 \times 10^{-6}}$$

$$= \frac{1.69}{3.14} \times 10^{-8+6}$$

$$= \frac{1.69 \times 10^{-2}}{1.34}$$

$R = 0.54 \times 10^{-2}\ \Omega$ OR $5.4\ m\Omega$ **Ans**

Example 16.4:

If the value of resistors R_1 and R_2 is 6k Ω and 4k Ω respectively and the voltage of battery is 10V, then find the following quantities.

(i) Equivalent resistance of the series combination.

(ii) The current flowing through each of the resistance.

(iii)Potential difference across each of the resistances.

Solution:

(i) $R_1 = 6k\ \Omega = 6 \times 10^3 \Omega$

(ii) $R_2 = 4\ k\ \Omega = 4 \times 10^3 \Omega$

If R_e is the equivalent resistance of this series combination.

$$R_e = R_1 + R_2$$
$$= 6 \times 10^3 + 4 \times 10^3$$
$$= (6+4) \times 10^3$$
$$= 10 \times 10^3\ \Omega$$

$\boxed{Re = 10\,k\Omega}$

$R_e = 10\ k\ \Omega$

(ii) If a battery of 10V is connected across the equivalent resistance, the current passing through it is given by:

$$I = \frac{V}{R_e}$$

$$= 10^{-3}\ A = \boxed{1\,mA}$$

According to definition of equivalent resistance same current would pass through each resistance of the series combination.

(iii) Potential difference across R_1,

$$V_1 = IR_1$$
$$= 10^{-3} \times 6 \times 10^3$$
$$= 6V$$

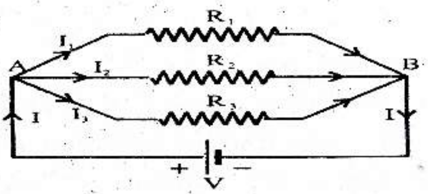
Potential difference across R_2,

$$V_2 = IR_2$$
$$= 10^{-3} \times 4 \times 10^{3}$$
$$= \boxed{4V}$$

Example 16.5:

If in the circuit shown in fig. $R_1 = 2\ \Omega$, $R_2 = 3\ \Omega$, $R_3 = 6\ \Omega$ and $V = 6V$, then find th following quantities?

(i) Equivalent resistance of the circuit.
(ii) Current flowing through each of the resistance.
(iii)The total current of the circuit.



Solution:

The given data is

$R_1 = 2\ \Omega$
$R_2 = 3\ \Omega$
$R_3 = 6\ \Omega$
$V = 6\ V$
$R_e = ?$

Currents $I_1, I_2, I_3 = ?$

Total current $= I = ?$

Formula:

(i) $$\frac{1}{R_e} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$$

Putting the value we get

$$\frac{1}{R_e} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$$

$$\frac{1}{R_e} = \frac{1}{2} + \frac{1}{3} + \frac{1}{6}$$

$$\frac{1}{R_e} = \frac{3+2+1}{6} = \frac{6}{6}$$

$$R_e = 1\ \Omega$$

(ii) $$I = \frac{V}{R}$$

Using this formula, we get

$$I_1 = \frac{V}{R_1} = \frac{6}{2} = 3\ A$$

$$I_2 = \frac{V}{R_2} = \frac{6}{2} = 2\ A$$

$$I_3 = \frac{V}{R_3} = \frac{6}{2} = 1\ A$$

(iii) Total current $= I = 3 + 2 + 1$

$$\boxed{I = 6\ A}$$

Example 16.6:

The resistance of an electric bulb is 500 Ω. When a potential of 250V is applied across its end, then find the power consumed by it.

Solution:

The given data is

Resistance = R = 500 Ω

Potential difference = V = 250V

Electric power = ?

Formula:

$$I = \frac{V}{R} = \frac{250}{500} = 0.5\ A$$

$$P = I^2R$$

$$= (0.5)^2 \times 500$$

0.25×500

$P = 125\ W$

Example 16.7:

In certain house, 4 electric bulbs of 100 W each, are daily used for 5 hours. If the rate of electricity is Rs. 4 per unit, find the number of units consumed in 30 days and what would be its cost?

Solution:

The number of units consumed $= \frac{\text{watt x time (in hours)}}{1000}$

$= \frac{4 \text{ x } 30 \text{ days x } 5\text{h x } 100 \text{ w}}{1000}$

= 60 kWh

= 60 units

Total cost = number of units consumed × cost of one unit

= 60 x 4

= Rs. 240/-

NUMERICAL PROBLEMS

16.1. 500 mA current is passing through a wire. Find the amount of charge that will flow through it in one hour.

Solution:

The given data is

Current = I = 500 mA

$= 50 \times 10^{-3}$ A

Charge = Q = ?

Time = t = 1 hour

= (1 x 60 x 60) s

$t = 3600\ s$

Formula:

$$\frac{Q}{t} = I$$

$$Q = I \times t$$

Putting values, we get

$$Q = (500 \times 10^{-3}) \times (3600)$$

$$\boxed{Q = 1800\ C}$$

16.2. Potential difference of 10V is applied across a conductor. If a current of 1.5 A is passing though it, How much energy would be obtained from the current in one minute?

Solution:

The given data is

Potential difference = V = 10 volts

Current = I = 1.5 A

Time = t = 1 min

= (1 x 60) s

= 60 sec

Formula:

$$E = W = QV$$

$$E = Itv \qquad \therefore Q = I \times t$$

Putting values, we get

Energy = (10) x (1.5) x (60)

$$\boxed{\text{Energy} = 900\ J}$$

16.3. When a potential of 10V is applied across a conductor, a current of 5mA flows through it. Find the resistance of the conductor.

Solution:

The given data is

Potential difference = V = 10 volts.

Current = I = 5mA

$= 5 \times 10^{-3}\ A$

Resistance = R = ?

Formula:

$$V = IR$$

$$R = \frac{V}{I}$$

Putting values, we get

$$R = \frac{10}{5 \times 10^{-3}}$$

$$R = 2 \times 10^{3}\ \Omega$$

$$\boxed{R = 2k\ \Omega}$$

16.4: The resistance of a conductor is 10 MΩ. If a potential of 100 volt is applied across its end, then find the current passing through it in mA.

Solution:

Resistance = R = 10MΩ

= $10 \times 10^{6}\Omega$

Potential difference = V = 100 volts

Current = I = ?

Formula:

$$V = IR$$

$$I = \frac{V}{R}$$

$$I = \frac{100}{10 \times 10^{6}}$$

$$I = 100 \times 10^{-7}\ A$$

$$I = 0.01 \times 10^{-3}\ A$$

$$\boxed{I = 0.01\ mA}$$

16.5: What would be the length of a copper wire of 3 mm diameter so that its resistance is equal to 0.005 ohm? Specific resistance of copper is 1.69×10^{-8} Ωm.

Solution:

Diameter = D = 3 mm

D = 3×10^{-3} m

Length = L = ?

Radius = $r = \frac{D}{2} = 1.5 \times 10^{-3}$ m

Resistance = R = 0.005 Ω

Specific resistance = ρ = 1.69×10^{-8} Ωm

Formula:

$$R = \frac{\rho L}{A}$$

$$L = \frac{RA}{\rho}$$

$$L = \frac{R \times \pi r^2}{\rho} \quad \text{-----------------------} \ (\therefore A = \pi r^2)$$

Putting values, we get

$$L = \frac{0.005 \times 3.14 \times (1.5 \times 10^{-3})^2}{1.69 \times 10^{-8}}$$

$$=\frac{0.005\times3.14\times1.5\times1.5\times10^{-6}}{1.69\times10^{-8}}$$

$$=\frac{5\times3.14\times1.5\times1.5\times10^{-9}}{1.69\times10^{-8}}$$

$$=\frac{5\times3.14\times2.25\times10^{-9}\times10^{-8}}{1.69}$$

$\boxed{L = 2.1\ m}$

16.6. Two resistances of $2k\Omega$ and $8k\Omega$ are connected in series. If a 10 V battery is connected across the ends of this combination, find the following quantities.

(a) The equivalent resistance of the series combination.

(b) Current passing through each of the resistances.

(c) The potential difference across each resistance.

Solution:

The given data is

$R_1 = 2\ k\Omega = 2 \times 10^3\ \Omega$

$R_2 = 8\ k\Omega = 8 \times 10^3\ \Omega$

Potential difference = voltage = V = 10V

(a) Equivalent resistance = R_e = ?

(b) Current through each resistance = ?

(c) Potential difference across each resistance = V_1 = ?

V_2 = ?

(a) Formula

$R_e = R_1 + R_2$

Putting value, we get

$R_e = 2\times10^3 + 8\times10^3$

$= (2+8)\times10^3$

$= 10 \times 10^3\ \Omega$

$10\ K\ \Omega$

(b) Formula

$I = \frac{V}{R_e}$ -------------------------- (by ohm's law)

Putting value, we get

$I = \frac{10}{10 \times 10^3}$

$I = 1 \times 10^{-3}$ A

$\boxed{I = 1\ mA}$

(c) Formula

$V = IR$

Putting value, we get

$V_1 = IR_1$

P. D. across 2kΩ resistance = $(1 \times 10^{-3}) \times (2 \times 10^3)$

$= 2$ V

$V_2 = IR_2$

P. D. across 8kΩ resistance = $(1 \times 10^{-3}) \times (8 \times 10^3)$

$= 8$ V

16.7. Two resistance of 6kΩ and 12k Ω are connected in parallel. 6V battery is connected across its ends. Find the values of the following quantities.

(a) Equivalent resistance of the parallel combination.

(b) Current passing through each of the resistances.

(c) Potential difference across each of the resistance.

Solution:

$R_1 = 6\ k\Omega = 6 \times 10^3\ \Omega$

$R_2 = 12\ k\Omega = 12 \times 10^3\ \Omega$

Equivalent resistance of the parallel combination = R_e = ?

Current passing through $R_1 = I_1$ = ?

Current passing through $R_2 = I_2$ = ?

Through $R_2 = I_2$ = ?

(a) Formula:

$$\frac{1}{R_e} = \frac{1}{R_1} + \frac{1}{R_2}$$

Putting value, we get

$$\frac{1}{R_e} = \frac{1}{6\times10^3} + \frac{1}{12\times10^3}$$

$$= \left(\frac{1}{6} + \frac{1}{12}\right) \times \frac{1}{10^3}$$

$$= \left(\frac{2+1}{12}\right) \times \frac{1}{10^3}$$

$$= \frac{1}{Re} = \frac{\cancel{3}}{\cancel{12}_4} \times \frac{1}{10^3}$$

$Re = 4 \times 10^3\ \Omega$

$\boxed{Re = 4\,k\Omega}$

(b) Formula:

$$I = \frac{V}{R}$$

Using values, we get

Current through $R_1 = I_1 = \dfrac{6}{6\times10^3}$

$= 1 \times 10^{-3}$ A

$= 1\ mA$

Current through $R_2 = I_2 = \frac{6}{12 \times 10^{-3}}$

$= 0.5 \times 10^{-3}\ A$

$= 0.5\ mA$

$V_1 = I_1R_1$

$= 1\times10^{-3} \times 6\times10^{3} = 6v$

$V_2 = I_2R_2$

$V_2 = 0.5\times10^{-3}\times12\times10^{3} = 6v$

Potential in each resistance during the parallel combination remains same as battery.

16.8. An electric motor is running with 220 V and 1.5 A current. Find the energy supplied by it in kilowatt-hour in 5 hours.

Solution:

The given data is

Potential difference = V = 220V

Current = I = 1.5 A

Time = t = 5 hours

Energy in kWh = ?

$P = IV = 1.5\times220 = 330W$

$$\text{Energy in Kwh} = \frac{P(\text{watt})\times\text{time (hours)}}{1000}$$

$$= \frac{330}{1000} \times 5$$

$$= \frac{165}{100} = \boxed{1.65\ Kwh}$$

16.9. An electric bulb is marked with 220V, 100W. Find the resistance of the filament of the bulb. If the bulb is used 5 hours daily, find the energy in kilowatt-hour consumed by the bulb in one month (30 days).

Solution:

Potential difference = V = 220 V

Power = P = 100 W

Resistance = R = ?

Total time = t = 5 x 30=150 hrs

Energy =?

Formula:

$$P = \frac{V^2}{R}$$

$$R = \frac{V^2}{P}$$

Putting values, we get

$$R = \frac{(220)^2}{100} = \frac{484 \times 100}{100}$$

$$\boxed{R = 484\ \Omega}$$

Formula:

$$\text{Energy in Kilowatt hours} = \frac{\text{Watt} \times \text{Time (hrs)}}{1000}$$

$$= \frac{10\cancel{0} \times 15\cancel{0}}{10\cancel{00}}$$

$= 15$kwh

Energy $= 15$kwh

16.10. A house is installed with.

- **(i)** 10 bulbs of 60 W each which are used 5 hours daily.
- **(ii)** 4 fans of 75 W each of which runs 10 hours daily.
- **(iii)** One electric iron of 1000 W which is used 2 hours daily.
- **(iv)** One T.V. of 100 W which is used 5 hours daily.
- **(v)** If the cost of one unit of electricity is Rs. 4. Find the monthly expenditure of electricity (1 month = 30 days)

Solution:

The given data

Number of bulb = 10

Power of one bulbs = 60 w

Power of 10 bulb $= 60 \times 10 = 600$ w

Time = t = 5x30 = 150 hrs

$$\text{Number of Units} = \frac{\text{Power (watt)} \times \text{time (hours)}}{1000}$$

$$= \frac{600 \times 150}{1000} = 90 \text{ units}$$

Number of fans = 4

Power of one fan = 75 w

Power of four fans $= 75 \times 4$

$= 300$ W

Time $= t = 10 \times 30 = 300$ hrs

$$\text{Units consumed by fans } \frac{\text{Power (watt)} \times \text{time (hours)}}{1000}$$

$$= \frac{30\cancel{0} \times 30\cancel{0}}{1\cancel{000}} = 90 \text{ Units}$$

Number of iron = 1

Power of Iron = 1000W

Time = t = 2x30 = 60 hrs

Units Consumed by bulb = $\frac{\text{Power (watt)} \times \text{time (hours)}}{1000}$

= $\frac{\cancel{1000} \times 60}{\cancel{1000}}$

= 60 Units

Number of T.V. = 1

Power of T.V. = 100W

Time = t = 5x30 = 150 hrs

Units consumed by T.V. = $\frac{1 \times 100 \times 150}{1000}$

= 15 Units

Total Units = 90 + 90 +60 + 15

= 255 Units

Cost of one unit = Rs. 4

Cost of electricity = ?

Cost of electricity = Total Units x cost of one unit = 255×4

= Rs.1020

MULTIPLE CHOICE QUESTIONS

Q. Circle the correct answer.

1. The ampere is a unit of:
- a) energy
- b) potential difference
- c) electric potential
- d) electric current

2. The rate of flow of charge through any cross-sectional area is called:
- a) Potential difference
- b) energy
- c) coulomb
- d) electric current

3. The flow of current in conductors is due to:
- a) Free electrons b) free protons
- c) free neutrons d) Atoms

4. Battery converts chemical energy into which energy:
- a) Mechanical b) Electrical
- c) Thermal d) none

5. The resistance of conductors is due to:
- a) Protons b) Fixed atoms
- c) Molecules d) Neutrons

6. The unit of potential difference is:
- a) volt b) coulomb
- c) ampere d) joule

7. According to Ohm's law:
V = ________
- a) I^2R b) IR^2
- c) IR d) $\frac{I}{R}$

8. What type of graph is in between: V and I?
- a) Curved b) Parabola
- c) Straight line d) none

9. The range of resistance thermometer is:
- a) -260°C – 630°C
- b) -260°C – 340°C
- c) -260°C – 660°C
- d) -260°C – 668°C

10. The formula to find temperature in Resistance thermometer is:

a) $T = \frac{R_T - R_o}{RT\propto}$ b) $T = \frac{R_o - R_T}{RT\propto}$

c) $T = \frac{R_T - R_o}{R_o\propto}$ d) $T = \frac{R_o - \propto}{RT\propto}$

11. The unit of (ρ) in formula $R = \frac{\rho.L}{A}$ is________:

a) Ω b) Ω-m

c) Ω-m^2 d) Ω-m^{-2}

12. The directed velocity of electrons in conductors is called:

a) Angular velocity

b) Circular velocity

c) Drift velocity

d) Average velocity

13. The unit of resistance is: *(L.B 2006)*

a) Ω-m b) Ω (ohm)

c) V d) C

14. Resistance of conductor is directly proportional to:

a) Length b) Pressure

c) Area d) all

15. The equivalent resistance in parallel combination is:

a) $R_e = R_1+R_2+R_3+\ldots\ldots+R_n$

b) $\frac{1}{R_e} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \ldots\ldots + \frac{1}{R_n}$

c) a & b d) none

16. Which instrument is used to detect current?

a) Galvanometer b) Voltmeter

c) Ammeter d) electroscope

17. How Galvanometer is connected to detect current?

a) In Series b) In Parallel

c) Fixed d) Variable

18. Joule's law is W = __________

a) $\frac{IR}{t}$ b) IRt^2

c) IR^2t d) I^2Rt

19. The unit of power is _________

a) volt b) watt

c) Joule d) coulomb

20. The A.C used in our houses has frequency ____cycle/sec

a) 60 b) 30

c) 50 d) 130

21. The current used in houses is:

a) Alternating current

b) Conventional current

c) Current d) direct current

22. The current which changes its direction is called:

a) Current

b) Conventional current

c) A.C

d) D.C

23. That period in which voltage repeats its value in equal intervals is called:

a) cycle b) Time period

c) Frequency d) Amplitude

24. The current which does not change its direction is called

a) A.C b) conventional

c) D.C d) Transient current

25. The resistance of voltmeter is:

a) zero b) low

c) very high d) 10 Ω

26. Specific resistance of silver = _________ x 10^{-8} Ohm-meter

a) 5.25 b) 2.75

c) 1.69 d) 1.62

27. Specific resistance of copper is _________ x 10^{-8} Ohm-meter

a) 1.62 b) 1.69

c) 5.25 d) 2.75

28. Current is equal to *(L.B 2005)*

a) IR^2 b) CV

c) $\frac{Q}{t}$ d) IR

29. As the temperature of a conductor rises, its resistance_____ (L.B '06) - II

a) Increases
b) Decreases
c) does not change
d) None

30. The property of substance, which opposes the flow of current through it is called, (L.B '06) - II

a) Resistance b) Reactance
c) Resistivity d) None

31. When resistances are connected in series the current passing through them is

a) different b) zero
c) the same
d) none of these

32. The equivalent resistance of a parallel combination is

a) equal to sum of all resistance
b) is greater than the largest resistance of combination
c) is smaller than the smallest resistance of combination
d) all of these

33. The unit of current is

a) Volt b) Ampere
c) Coulomb d) Farad

ANSWERS

1.	d	**2.**	d	**3.**	a	**4.**	b	**5.**	b	**6.**	a	**7.**	c
8.	c	**9.**	a	**10.**	c	**11.**	b	**12.**	c	**13.**	b	**14.**	a
15.	b	**16.**	a	**17.**	a	**18.**	d	**19.**	b	**20.**	c	**21.**	a
22.	c	**23.**	b	**24.**	c	**25.**	c	**26.**	d	**27.**	b	**28.**	c
29.	a	**30.**	a	**31.**	c	**32.**	c	**33.**	b				

SHORT ANSWERS

Q.1: What do you mean by alternating current (A.C)?

Ans. The current which changes its direction again and again with time is called alternating current or A.C.

Q.2: What do you mean by direct current or D.C? (L.B '10)

Ans. The current which does not change its direction of flow is known as direct current or D.C.

Q.3: What is Joule's Law?

Ans. "The amount of heat energy generated in a resistance is due to flow of electric current is equal to product of square of current 'I', resistance 'R' and time duration 't' i.e. $W = I^2Rt$. This is called Joule's Law".

Q.4: What is kilowatt hour (KWh)?

Ans. It is the amount of energy obtained from a power of one kilowatt in one hour. It is equal to 3.6 mega joule.

Q.5: What is electric current?

Ans. The rate of flow of electric charge through any cross-sectional area is called electric current. Mathematically $I = \frac{Q}{t}$

Q.6: In metals, how electric current is produced?

Ans. In metals the current is produced only due to the flow of free electrons or negative charges.

Q.7: How current is produced in electrolytes?

Ans. In electrolytes, the current is produced due to flow of both the positive and negative charges.

Q.8: What do you mean by resistance? (L.B '08, 09)

Ans. The property of a substance which opposes the flow of current through it is called resistance.

Q.9: What do you mean by specific resistance?

Ans. The resistance of one-meter cube of a substance is called specific Resistance. $R = \rho\frac{L}{A}$ of $L = 1m$ & $A = 1m^2$ then $R = \rho$

Q.10: Define unit of Resistance (OR) Define Ohm.

Ans. A material has a resistance of one 0hm (1 0hm) if there is a current of one ampere flowing through it when the potential difference across it is 1 volt.

Q.11: What is drift velocity?

Ans. When we apply potential difference across the ends of the conductor, the free electrons in addition to their random motion have directed motion with a velocity is known as drift velocity.

Q.12: What is conventional current?

Ans. The current due to flow of positive charges is equivalent to the current due to flow of negative charges in the opposite direction is called convential current.

Q.13: What is Electromotive force?

Ans. The energy needed to move one coulomb charge through the whole circuit including the battery is called electromotive force or (emf).

Q.14. What is the net result in the absence of electric field? / Why current cannot pass through conductor in normal state?

Ans. In the absence of electric field, the rate at which the free electrons cross any section of the wire from right to left is equal to left to right; hence net rate is zero, so in spite of the fact that electrons are in motion no current flows through any section of the conductor.

Q.15. What is temperature co-efficient of resistance?

Ans. The change in resistance per unit original resistance per Kelvin rise in temperature is called temperature coefficient of resistance.

$$\text{Mathematically } \alpha = \frac{R_T - R_o}{R_o T}$$

Q.16. What is parallel combination of resistance?

Ans. If a number of resisters are connected side by side with their ends joined together at common point, then it is called parallel combination.

Q.17. What is equivalent resistance?

Ans. A single resistance obtained by replacing a number of resistances in a combination giving similar effects is called equivalent resistance.

$$\text{For Parallel Combination: } \frac{1}{R_e} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \ldots\ldots\ldots\ldots + \frac{1}{R_n}$$

For series combination: $R_e = R_1 + R_2 + R_3 + \ldots\ldots\ldots\ldots + R_n$

Q.18. What is series combination of resistance?

Ans. If the resistances are connected end to end such that the same current passes through all of them, then it is called series combination of resistances.

Q.19. What is galvanometer?

Ans. It is a sensitive instrument which is used to detect the presence of current in circuit.

Q.20. What is ammeter?

Ans. Ammeter is an instrument used to measure electric current.

Q.21. What is voltmeter?

Ans. It is an instrument used to measure potential difference between two points.

Q.22. What is electric power?

Ans. The amount of energy supplied by current in unit time is called electric power. Mathematically,

$$P = \frac{W}{t}$$

Q.23. Prove 1 KWh = 3.6×10^6 J

Ans. 1 kwh = 1000 watt x 1 hour

$$= 1000 \frac{J}{sec} \times 3600 \text{ sec}$$

$$10^3 \times 36 \times 10^2 \text{ J}$$

$$36 \times 10^5 \text{ J}$$

$$1 \text{ kwh} = 3.6 \times 10^6 \text{ J}$$

Q.24. What is circuit breaker? Write its working principle. **(L. B '10)**

Ans. A safety device used in place of fuse is called circuit breaker. It breaks the electric circuit if current increases beyond the given rating. It works on the principle of electromagnet.

Q.25. How ammeter is connected in circuit?

Ans. In order to measure current in a circuit, the ammeter is connected in series, so the current passes in circuit also passes through the ammeter.

Q.26. Is there any effect on current, when ammeter is connected in a circuit?

Ans. There is no effect upon the current of the circuit, as the resistance of ammeter is very small.

Q.27. How galvanometer is converted into an ammeter? (OR) What is shunt? **(L. B '08)**

Ans. Galvanometer is converted into an ammeter by connecting a suitable low resistance in parallel with the galvanometer which is called shunt.

Q.28. How galvanometer is converted into voltmeter?

Ans. Galvanometer is converted in voltmeter by connecting a suitable high resistance in series with the galvanometer.

Q.29. How voltmeter is connected in circuit?

Ans. Voltmeter is always connected in parallel with resistance across which the potential differenced is to be measured.